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ANATOMY OF *VETIVERIA ZIZANIOIDES* (L.) NASH

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ABSTRACT

Vegetative anatomy of the root, stem and leaf of *Vetiveria zizanioides* (L.) Nash has been studied. Air cavities in the leaf-sheath and blade show stellate cells representing diaphragm interspersed by sclerotic strands which earlier have not been reported. The origin and structure of the diaphragm and the sclerotic strand have also been worked out.

INTRODUCTION

Extensive information on the anatomy of grasses have been provided by Metcalfe (1960). The anatomy of the leaf of *Vetiveria zizanioides* (L.) Nash has been reported by Prat (1936) and Majumdar (1963) besides Metcalfe (1960). No information is available on the anatomy of the root and stem of this important essential oil grass. The present study is on the anatomy of the root, stem and certain aspect of the leaf which has not been recorded previously.

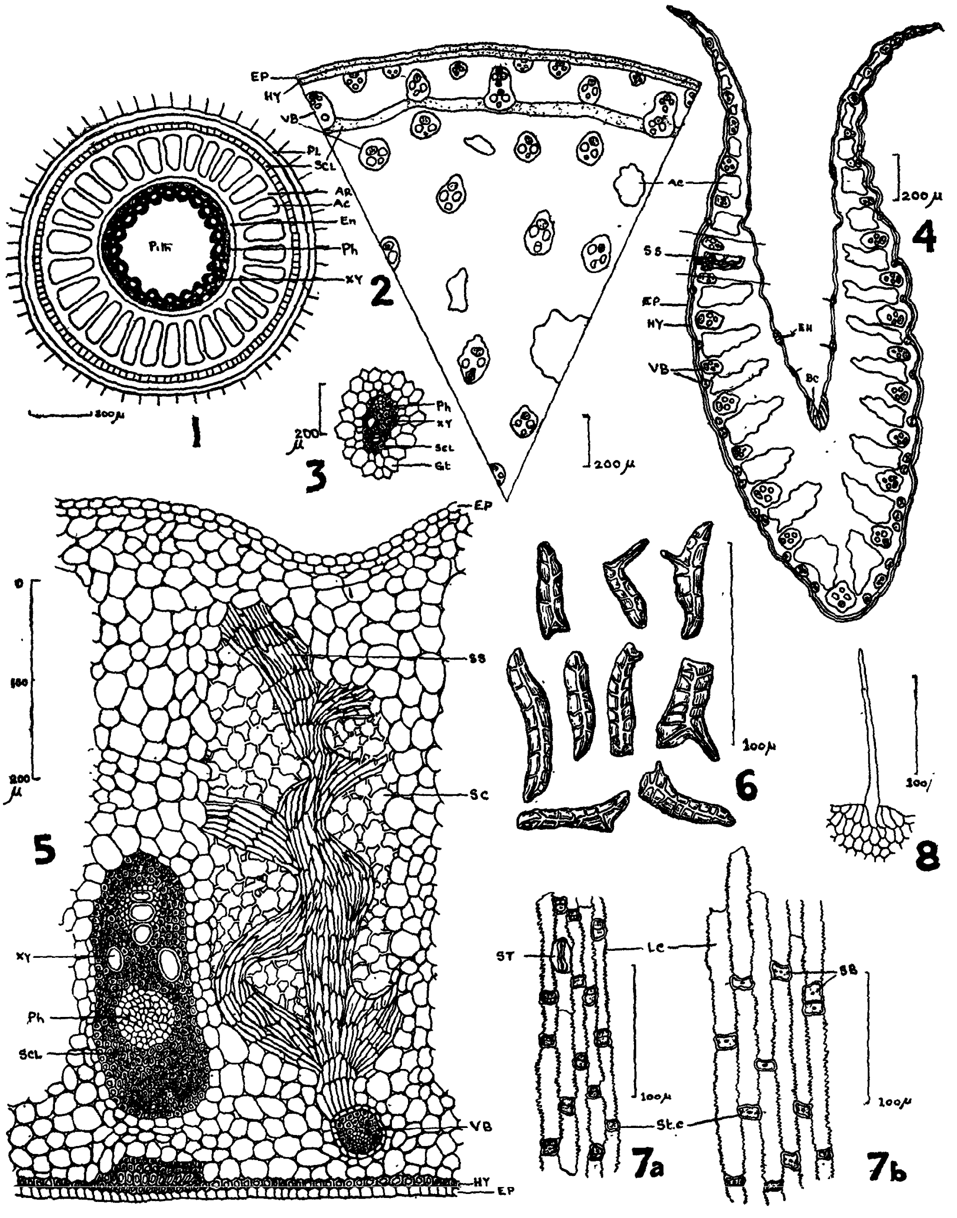
Materials supplied by Dr. M. A. Rau from Dehra Dun [Mothronwala, 700 m, *P. C. Pant* 31885 (CAL)] and those collected from suburbs of Calcutta [Dum Dum, Duttapukur, *Korlahalli* 656 (CAL)] were used. Hand sections of stem, root and leaf and microtome sections of young leaf-sheath were prepared following the usual procedure: leaf maceration following Jeffery's method as outlined by Foster (1950) and leaf clearing in sodium hydroxide were also made. Pieces of leaf-blade were burnt in a crucible and mounted in xylol to study silica body.

Root: Root anatomy shows usual monocotyledonous features (Text fig. 1). The piliferous layer is followed by a heterogenous cortex consisting of outer two layers of thin-walled parenchyma cells followed by 2-3 layers of small sclerenchyma cells; the inner cortex is aerenchymatous with lysigenously formed air spaces. Rows of cells, usually one cell wide and 10-15 cells deep, separate the air spaces. The stele is surrounded by a well defined endodermis with casparian thickenings. The endodermal cells show conspicuously thickened radial and inner tangential walls. The pericycle is single layered. The peripherally arranged vascular bundles are exarc, radial and closed. The central pith consists of starch filled parenchyma cells which ultimately become thick-walled in older roots.

Stem: Young culms are solid; older ones develop air cavities by the disintegration of ground tissue. The stem shows in general anatomy of the grass type (Text fig. 2). In surface view the epidermal cells are seen differentiated into 'long cells' and 'short cells' as in the leaf epidermis. In transection the epidermal cells are small and rectangular in outline. Adjoining the epidermis is a layer of small thick-walled hypodermis. Vascular bundles are several; the peripheral ones are arranged in two rings which are separated by a band of 2-4 layers of small sclerenchyma cells. The outer ring of vascular bundles are small, about 30-40 in number and are seen adjoining the hypodermis. Each vascular bundle of the outer ring is separated by a few larger cells. The inner ring of vascular bundles are bigger when compared to those of the outer ring and 15-20 in number. These bundles are seen attached to the sclerenchyma band. The rest of the vascular bundles are scattered in the inner ground tissue made up of large parenchyma cells. The vascular bundles are endarc, collateral, closed and ensheathed by sclerenchyma cells (Text fig. 3). A gradual reduction in the sclerenchyma is noticed from the peripheral to the centrally situated vascular bundles.

Leaf-sheath and blade (Text fig. 4): Anatomy of the leaf-blade agrees in general as described by Metcalfe (1960). Epidermal cells are small, thick-walled on the outer surface. Bulliform cells are present on the adaxial side in the midrib region of the leaf-blade. A few epidermal hairs are seen on the adaxial side along the lower portions of the leaf-blade. The lower portion of the epidermal hair is surrounded by prominent cells resembling bulliform cells (Text fig. 8). In surface view the epidermal cells are of two types: 'the long cells' and 'the short cells' (Text figs. 7a, 7b). The long cells are rectangular, 3-6 times longer than broad and possess sinuous walls. They are narrower on the coastal zone (Text fig. 7a). They alternate with short cells numbering 1-3.

Each short cell contains a single silica body which is cross-shaped, rectangular or constricted in the middle. The stomata are mostly confined to the intercoastal zone and are arranged in two rows adjoining the costae. The guard cells are dumb-bell shaped and subsidiary cells are somewhat triangular or dome-shaped. The interstomatal epidermal cells have concave end walls.



Text figs. 1-8: *Vetiveria zizanioides* (L.) Nash: 1. T. S. of root (diagramatic). 2. A portion of stem in T. S. (diagramatic). 3. A vascular bundle of the stem. 4. T. S. of leaf-blade (diagramatic). 5. T. S. of leaf-blade—a portion showing the diaphragm (marked in Text fig. 4) enlarged. 6. A few macerated cells from the sclerotic strand. 7. Surface view of leaf epidermis (macerated). *7a*. From coastal zone: *7b*. From intercoastal zone. 8. Epidermal hair.

AC. Air cavity. AR. Aerenchyma. BC. Bulliform cells. EH. Epidermal hair. EN. Endodermis. Gt. Ground tissue. Hy. Hypodermis. LC. Long cells. Ph. Phloem. PL. Piliferous layer. SB. Silica body. SC. Stellate cells. SCL. Sclerenchyma. St. C. Short cells. ST. Stomata. VB. Vascular bundle. XY. Xylem.

Both in the leaf-sheath and blade a number of air cavities are seen uniformly distributed on either halves; these air cavities gradually become smaller and finally disappear toward the margins. The air cavities are separated by vertical columns of parenchyma cells encircling a triangular to oval-shaped vascular bundle on the abaxial side. The sclerenchyma sheaths of the vascular bundles are more prominent on the abaxial side. In addition, small vascular bundles with poorly developed xylem and phloem are seen alternating with the larger ones just adjoining the hypodermis on the abaxial side. Parenchyma cells are seen adjoining the air cavities. Some of the air cavities are filled with stellate cells interspersed by branched sclerotic strands which have not been recorded previously in this grass (Text fig. 5). However, Duval-Jouve (1871) records presence of diaphragm in certain grasses. Metcalfe (1960) has observed diaphragm in *Zizania latifolia* (Griseb.) Truez and stellate cells in the air cavities of *Glyceria fluitans* (L.) R. Br.

Leaf clearings reveal the presence of sclerotic strands in all air cavities but at various levels, hence their presence is noticed only in one or two air cavities in a transection. Certain branches of sclerotic strands are connected to vascular tissue.

Maceration of sclerotic strands shows that they are made up of bundles of small, intertwined, polymorphic cells, irregular in outline and with striated lignified walls having simple pits (Text fig. 6).

Microtome sections of very young leaf-sheaths reveal certain cells in the mesophyll region surrounding the air cavities, undergoing active longitudinal divisions giving rise to sclerotic initials, while certain other mesophyll cells around the sclerotic initials differentiating into long-armed, thin walled stellate cells. The sclerotic initials undergo further longitudinal divisions and finally develop lignified walls with simple pits. Some of them are connected to the vascular bundles. Thus at certain regions along the air cavities, diaphragms are formed by the sclerotic cells and the thin walled cells; probably the former cells are serving as mechanical tissues.

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